CLAIMS

1. A method for producing ammonia gas from liquid water and nitrogen, comprising the steps of:

feeding a quantity of de-ionized water to a hydrogen generator;

producing a quantity of hydrogen from the quantity of de-ionized water utilizing said hydrogen generator;

producing a quantity of purified hydrogen by passing said quantity of hydrogen through a hydrogen purifier;

producing a quantity of purified nitrogen by passing a quantity of nitrogen through a nitrogen purifier; and,

contacting said quantity of purified hydrogen and said quantity of purified nitrogen with a catalyst bed, wherein a portion of said purified hydrogen and a portion of said purified nitrogen react to form a quantity of ammonia.

2. The method as recited in claim 1, further comprising the step of:

de-gassing said quantity of de-ionized water prior to feeding the de-ionized water to said hydrogen generator, to remove a portion of dissolved gasses in said quantity of de-ionized water.

3. The method as recited in claim 2, wherein said quantity of de-ionized water is de-gassed in a membrane contactor, having a first stage followed by a second stage.

4. The method as recited in claim 3, wherein in said first stage, a first portion of said dissolved gassed are removed by nitrogen stripping.

5. The method as recited in claim 3, wherein in said second stage, a second portion of said dissolved gasses are removed by vacuum stripping.

6. The method as recited in claim 1, further comprising the step of:

compressing said quantity of purified hydrogen and said quantity of purified nitrogen prior to contacting said quantity of purified hydrogen and said quantity of purified nitrogen with said catalyst bed.

7. The method as recited in claim 6, wherein said quantity of purified hydrogen and said quantity of purified nitrogen are compressed to a pressure between 10 and 100 atmospheres, absolute.

8. The method as recited in claim 1, further comprising the step of:

producing a quantity of purified ammonia by passing said quantity of ammonia through an ammonia purifier.

9. The method as recited in claim 8, further comprising the step of:

delivering a portion of said quantity of purified ammonia to a semiconductor process tool.

10. The method as recited in claim 8, wherein said ammonia purifier comprises a high surface area metal oxide comprising oxides of barium, calcium, iron, lithium, manganese, molybdenum, potassium, rhenium, sodium, strontium, titanium, tungsten, and vanadium.

11. The method as recited in claim 8, wherein at least one of said ammonia purifier, said hydrogen purifier, and said nitrogen purifier are regenerated with a portion of said quantity of purified hydrogen.

12. The method as recited in claim 8, wherein the concentration of an impurity in said quantity of purified ammonia is reduced to less than 50 ppb.

13. The method as recited in claim 8, wherein the concentration of an impurity in said quantity of purified ammonia is reduced to less than 10 ppb.

14. The method as recited in claim 1, wherein said hydrogen purifier comprises:

a high surface area metal oxide comprising oxides of barium, calcium, iron, lithium, manganese, molybdenum, nickel, potassium, rhenium, sodium, strontium, titanium, tungsten, and vanadium; and,

optionally, metallic nickel.

15. The method as recited in claim 1, wherein said nitrogen purifier comprises a nickel catalyst.

16. The method as recited in claim 1, wherein said hydrogen generator produces hydrogen from water by electrolytic means.

17. The method as recited in claim 1, wherein the concentration of an impurity in said quantity of purified hydrogen is reduced to less than 50 ppb.

18. The method as recited in claim 1, wherein the concentration of an impurity in said quantity of purified nitrogen is reduced to less than 50 ppb.

19. The method as recited in claim 1, wherein the concentration of an impurity in said quantity of purified hydrogen is reduced to less than 10 ppb.

20. The method as recited in claim 1, wherein the concentration of an impurity in said quantity of purified nitrogen is reduced to less than 10 ppb.

21. A method for producing point of use ammonia gas from liquid water and nitrogen, comprising the steps of:

de-gassing a quantity of de-ionized water, to remove a portion of dissolved gasses in said quantity of de-ionized water;

feeding a quantity of said de-ionized, de-gassed water to a hydrogen generator;

producing a quantity of hydrogen from the quantity of said de-ionized, de-gassed water utilizing said hydrogen generator;

producing a quantity of purified hydrogen by passing said quantity of hydrogen through a hydrogen purifier;

producing a quantity of purified nitrogen by passing a quantity of nitrogen through a nitrogen purifier;

compressing said quantity of purified hydrogen and said quantity of purified nitrogen;

contacting said compressed quantity of purified hydrogen and said compressed quantity of purified nitrogen with a catalyst bed, wherein a portion of said purified hydrogen and a portion of said purified nitrogen react to form a quantity of ammonia;

producing a quantity of purified ammonia by passing said quantity of ammonia through an ammonia purifier; and,

delivering a portion of said quantity of purified ammonia to a semiconductor process tool.